TOUCH SCREEN SYSTEM WITH HOVER AND CLICK INPUT METHODS

RELATED APPLICATIONS

[0001] This application claims priority to New Zealand Provisional Patent Application No. 554,416, entitled "Touch Screen with Hover and Click Input Methods," which was filed in the New Zealand Patent Office on Apr. 11, 2007.

TECHNICAL FIELD

[0002] The present invention relates generally to touch sensitive screens, also referred to as touch screens. More particularly, the present invention relates to systems and methods for using signal processing to optically detect user interactions with a touch screen representing tracking, selecting and dragging operations.

BACKGROUND OF THE INVENTION

[0003] Touch screen systems of the prior art can be categorized into the following technology groups: resistive, surface capacitive, projected capacitive, surface acoustic wave (SAW), infrared (IR), Frustrated Total Internal Reflection (FTIR), optical, and dispersive signal (bending wave). Each type of touch screen technology has its own features, advantages and disadvantages. With all such technologies, the size of human fingers and the lack of sensing precision can make precise touch screen interactions difficult. Most conventional touch screen systems do not address the needs of current user interfaces that require at least four different interaction states: (1) out-of-range; (2) tracking (also known as "hover" or "proximity"); (3) selection (also known as "click"); and (4) dragging.

[0004] By way of contrast, traditional computer input devices, such as mice, pens and touch pads, allow a user to perform tracking, dragging and selection operations. A mouse, for example, allows a user to track a cursor around a display computer screen independently from clicking a button to make a selection, or to perform a dragging operation by maintaining a button in a depressed state when manipulating the mouse. Pens and touch pads have the ability to directly measure contact pressure and thus use detected changes in pressure over time to distinguish between tracking, dragging and selection operations. The ability to position the cursor and then optionally press or trigger a button is important in many software applications and allows a more precise input mode. There is therefore a general need for such functionality in the field of touch screen technology.

[0005] In order to detect tracking and dragging states, any touch screen system must be able to continuously detect and report the position of the user's finger or stylus. However, most conventional touch screen systems register a selection (i.e., a "click") only when contact between the user's finger or stylus and the touch screen surface is either established or broken, and thus do not provide for separate tracking or dragging operations. As one exception, Benko et al. have demonstrated in their paper entitled *Precise Selection Techniques for Multi-Touch Screens* (*Proc. ACM CHI* 2006*: Human Factors in Computing Systems*, pp. 1263-1272), that an FTIR touch screen system, which directly senses the area of a touch, can be adapted to detect variations in the area of the touch over time in order to approximate tracking and dragging states. The technique described by Benko et al. is referred to as SimPress and is said to reduce motion errors during clicking and allow the simulation of a hover state on devices unable to sense proximity.

[0006] The SimPress technique is similar to that used by pressure-sensitive touch pads and pen interfaces for computers. All of these technologies require the ability to directly sense the pressure or area of a touch (i.e., the surface area of the touch screen contacted by a finger or stylus) and thus are not applicable in touch screen systems that lack such ability, including infrared touch screen systems and optical touch screen systems. In addition, due to the manner in which variations in touch area are calculated, the SimPress technique only works if the user always approaches the tabletop touch screen from the same direction. What is needed, therefore, is a touch screen system that can approximate tracking and dragging states, regardless of the user's orientation and without reliance on direct sensing of touch pressure or area.

[0007] Infrared touch screen technology relies on the interruption of an infrared light grid that is positioned in front of the display screen. A "touch frame" or "opto-matrix frame" typically contains a row of infrared LEDs and a row of photo transistors; each mounted on two opposite sides to create a grid of invisible infrared light. The frame assembly is comprised of printed wiring boards on which the opto-electronics are mounted and is concealed behind an infrared-transparent bezel. The bezel shields the opto-electronics from the operating environment while allowing the infrared beams to pass through.

[0008] An infrared controller sequentially pulses the LEDs to create a grid of infrared light beams. When a stylus or finger enters the grid, it obstructs some of the light beams. One or more phototransistors detect the absence of light and transmit a signal that can be used to identify the x and y coordinates of the touch. Infrared touch screen systems are often used in manufacturing and medical applications because they can be completely sealed and operated using any number of hard or soft objects. The major issue with infrared touch screen systems is that the "seating" of the touch frame is slightly above the screen. Consequently, the touch screen is susceptible to "early activation" before the finger or stylus has actually touched the screen. The cost to manufacture the infrared bezel is also quite high.

[0009] Optical touch screen systems rely on a combination of line-scan or area image cameras, digital signal processing, front or back illumination and algorithms to determine a point of touch. Many optical touch screen systems use line-scanning cameras, orientated along the touch screen surface so as to image the bezel. In this way, the system can track the movement of any object close to the surface of the touch screen by detecting variations in illumination emitted by an illumination source, such as an infrared light source. For example, infrared light may be emitted across the surface of the touch screen either by infrared light emitting diodes (IR-LED) or by special reflective surfaces. Optical touch screen technology shares some of the advantages and disadvantages of infrared touch screen technology. One such disadvantage is that touches are typically registered just before the finger or object actually touches the touch screen surface. The most significant advantages of optical touch screen technology include lower incremental cost as size increases and substantially higher resolution and data rate, which translate into much better drag-and-drop performance.